CLAIMS

1. (previously presented) A vertical cavity surface emitting laser comprising:

a lower distributed Bragg reflector;

an active region positioned on the lower distributed Bragg reflector;

an upper distributed Bragg reflector positioned on the active region;

a cylindrical volume removed from the upper distributed Bragg reflector defining a mesa with a substantially vertical side wall concentrically surrounded by the cylindrical volume, an isolation trench formed in a lower surface of the cylindrical volume concentric with the mesa;

an implant region including a portion of the side wall of the mesa and a portion of the upper distributed Bragg reflector below the lower surface of the cylindrical volume;

a planarizing material filling the cylindrical volume; and

n and p electrical contacts coupled to opposite sides of the active region for supplying operating current thereto;

wherein the lower surface of the cylindrical volume is formed so that more mirror pairs of the upper distributed Bragg reflector remain adjacent the mesa and less mirror pairs remain as the lateral distance from the mesa increases.

2. (original) A vertical cavity surface emitting laser as claimed in claim 1 wherein the lower surface of the cylindrical volume forms an angle greater than ninety degrees with the side wall of the mesa.

3. Cancelled

4. (previously presented) A vertical cavity surface emitting laser as claimed in claim 1, wherein the implant region in the lower surface of the cylindrical volume extends at least into the active region adjacent the isolation trench.

5. (original) A vertical cavity surface emitting laser as claimed in claim 1 wherein the planarizing material filling the cylindrical volume includes a low-k dielectric material.

6. (original) A vertical cavity surface emitting laser as claimed in claim 1 wherein the implant region includes at least some of the cylindrical volume surface.

7. (original) A vertical cavity surface emitting laser as claimed in claim 1 wherein the implant region includes proton implants.

8. (original) A vertical cavity surface emitting laser comprising:

a lower distributed Bragg reflector including a plurality of pairs of mirror elements;

an active region positioned on the lower distributed Bragg reflector;

an upper distributed Bragg reflector including a plurality of pairs of mirror elements positioned on the active region;

a cylindrical volume removed from the upper distributed Bragg reflector defining a mesa with a substantially vertical side wall concentrically surrounded by the cylindrical volume, an isolation trench formed in a lower surface of the cylindrical volume concentric with the mesa, the lower surface of the cylindrical volume being formed so that more mirror pairs of the upper distributed Bragg reflector remain adjacent the mesa and less mirror pairs remain as the lateral distance from the mesa increases whereby the lower surface of the cylindrical volume forms an angle greater than ninety degrees with the side wall of the mesa;

an implant region adjacent a surface of the cylindrical volume including the side wall of the mesa and the upper distributed Bragg reflector defining the lower surface of the cylindrical volume;

a planarizing material filling the cylindrical volume; and

n and p electrical contacts coupled to opposite sides of the active region for supplying operating current thereto.

9. (previously presented) A method of fabricating a high frequency vertical cavity surface emitting laser comprising the steps of:

a) providing a lower distributed Bragg reflector on a substrate, an active region on the lower distributed Bragg reflector, and an upper distributed Bragg reflector on the active region;

b) etching a cylindrical volume from the upper distributed Bragg reflector to define a mesa with a substantially vertical side wall, the cylindrical volume extending into the upper distributed Bragg reflector to a lower surface adjacent the active region;

c) etching an isolation trench in the lower surface of the cylindrical volume concentric with the mesa and extending through the active region;

d) implanting a portion of the side wall of the mesa and the lower surface of the cylindrical volume; and

e) planarizing the upper distributed Bragg reflector and coupling n and p electrical contacts to opposite sides of the active region for supplying operating current thereto; wherein step b) includes etching the cylindrical volume so that the lower surface of the cylindrical volume forms an angle greater than ninety degrees with the side wall of the mesa, and etching the cylindrical volume so that more mirror pairs of the upper distributed Bragg reflector remain adjacent

the mesa and less mirror pairs remain as the lateral distance from the mesa increases.

10. (Cancelled)

11. (Cancelled)

12. (previously presented) The method of claim 9, wherein step d) includes proton implanting the side wall of the mesa and the lower surface of the cylindrical volume.

13. (previously presented) The method of claim 12, wherein step d) includes implanting the lower surface of the cylindrical volume so that the implant extends at least into the active region adjacent the isolation trench.

14. (previously presented) The method of claim 9, wherein step a) includes epitaxially growing the lower distributed Bragg reflector on the substrate, epitaxially growing the active region on the lower distributed Bragg reflector, and epitaxially growing the upper distributed Bragg reflector on the active region.

15. (previously presented) The method of claim 9, wherein step e) includes filling the cylindrical volume with one of benzocyclobutene (BCB) dielectric and a polyimide material.

16. (original) A method of fabricating a high frequency vertical cavity surface emitting laser comprising the steps of:

epitaxially growing a lower distributed Bragg reflector on a substrate, epitaxially growing an active region on the lower distributed Bragg reflector, and epitaxially growing an upper distributed Bragg reflector on the active region;

etching a cylindrical volume from the upper distributed Bragg reflector to define a mesa with substantially vertical side wall, the upper distributed Bragg reflector being etched so that a lower surface of the cylindrical volume forms an angle greater than ninety degrees with the side wall of the mesa, and further etching the cylindrical volume so that more mirror pairs of the upper distributed Bragg reflector remain adjacent the mesa and less mirror pairs remain as the lateral distance from the mesa increases;

etching an isolation trench in the lower surface of the cylindrical volume concentric with the mesa and extending through the active region;

proton implanting a portion of the side wall of the mesa and the lower surface of the cylindrical volume; and

planarizing the upper distributed Bragg reflector and coupling n and p electrical contacts to opposite sides of the active region for supplying operating current thereto.

17. (original) The method of claim 16 wherein the step of proton implanting the lower surface of the cylindrical volume includes implanting the lower surface of the cylindrical volume so that the implant extends at least into the active region adjacent the isolation trench.

18. (original) The method of claim 16 wherein the step of planarizing includes filling the cylindrical volume with one of BCB dielectric and a polyamide.

19. (previously presented) A vertical cavity surface emitting laser comprising:

a lower distributed Bragg reflector including a plurality of pairs of mirror elements;

an active region positioned on the lower distributed Bragg reflector;

an upper distributed Bragg reflector including a plurality of pairs of mirror elements positioned on the active region;

a cylindrical volume removed from the upper distributed Bragg reflector defining a mesa with a substantially vertical side wall concentrically surrounded by the cylindrical volume, the lower surface of the cylindrical volume being formed so that more mirror pairs of the upper distributed Bragg reflector remain adjacent the mesa and less mirror pairs remain as the lateral distance from the mesa increases whereby the lower surface of the cylindrical volume forms an angle greater than ninety degrees with the side wall of the mesa;

an implant region adjacent a surface of the cylindrical volume including the side wall of the mesa and the upper distributed Bragg reflector defining the lower surface of the cylindrical volume;

a planarizing material filling the cylindrical volume; and

n and p electrical contacts coupled to opposite sides of the active region for supplying operating current thereto.

20. (previously presented) A vertical cavity surface emitting laser as claimed in claim 19, wherein the implant region in the lower surface of the cylindrical volume extends at least into the active region.

21. (currently amended) A vertical cavity surface emitting laser as claimed in claim 19, wherein implant region in the lower surface of the cylindrical volume extends into the [[a]] lower distributed Bragg reflector.

22. (currently amended) A vertical cavity surface emitting laser as claimed in claim 1, wherein implant region in the lower surface of the cylindrical volume extends into the [[a]] lower distributed Bragg reflector.

23. (previously presented) The method of claim 12, wherein step d) includes implanting the lower surface of the cylindrical volume so that the implant extends into the lower distributed Bragg reflector adjacent the isolation trench.